

## SECTION 410 — PILING

**410.01 DESCRIPTION.** This work shall consist of furnishing and installing piling as specified in the Contract Documents or as directed by the Engineer. When drilled shafts (caissons) are specified refer to Section 412.

### 410.02 MATERIALS.

Sand	901.01
Concrete for Steel Pipe Piles	902.10, Mix No. 3 Slump 4-6 in.
Tremie Concrete for Steel Pipe Piles	902.10, Mix No. 4
Timber Piles	907.01
Timber Sheet Piles	907.01
Resin and Fiberglass Caps	907.01.01
Steel Pipe Piles	907.02
Steel H Piles	907.03
Steel Sheet Piles	907.04
Reinforcement for Steel Pipe Piles	908.01
Hardware	909.10
Water	921.01
Timber Preservatives	921.06

**410.03 CONSTRUCTION.** The Contractor shall be responsible for ordering and delivering piling of the proper type and length to the structure site.

**410.03.01 Storage and Handling.** Piling shall be stored and handled to avoid damage. Damaged piling shall be repaired or replaced as directed by the Engineer.

**410.03.02 Preparation for Driving.** Piling shall not be driven until embankments and excavation have been completed as specified in the Contract Documents or as directed by the Engineer.

The Contractor shall provide templates or other approved means to assure that the piles are properly aligned and positioned.

The heads of all piling shall be equipped with a cap or cushion so that the energy imparted by the hammer can be transmitted to the pile evenly without injury to the top or butt. The top of the pile, irrespective of its type, shall be normal to the axis of the moving parts of the hammer.

**410.03.03 Pile Tips.**

- (a) Timber piles shall be pointed where driving conditions require. The point shall be symmetrical and not less than a 4 in. diameter. Timber piles shall have their tips or bottoms shod with a metal shoe or point when specified in the Contract Documents or as directed by the Engineer.
- (b) Timber sheet piling shall be drift sharpened or beveled at the bottom to wedge contiguous piles in tighter contact.
- (c) Steel H piles shall be driven without any special tip reinforcement unless otherwise specified in the Contract Documents.
- (d) Steel pipe piles shall be driven open ended.

**410.03.04 Splicing.** Splicing of timber piles is prohibited. In event of an isolated timber pile penetrating below planned tip elevation resulting in the top being below planned elevation, the Engineer will determine when replacement is required, supplemented by an additional pile or when the structure can be changed without detriment.

When splicing of steel H piles and steel pipe piles is necessary, they shall be spliced as specified in the Contract Documents by electric arc welding conforming to AWS Structural Welding Code for the full periphery. The number of splices permitted shall be compatible with driving conditions at the site and the standard lengths of piling produced by manufacturers; however, only one section of each pile shall be less than 20 ft.

When welding is required above a maximum elevation specified in the Contract Documents, it shall be performed in conformance with 430.03 excluding the submerged arc welding requirement. Welders shall be qualified in conformance with 430.03.19(a) or (b) for steel pipe piles 24 in. in diameter or greater, and in conformance with 430.03.19(b) for pipe piles less than 24 in. in diameter.

All welding above these limits shall receive 100 percent Magnetic Particle Inspection (MT) on the root pass and completed weld, and 100 percent Radiographic Inspection (RT), in conformance with AWS D1.5. Inspectors shall be approved by the Office of Materials and Technology, Metals Group as specified for certification testing in conformance with AWS D1.5.

Inspectors certified by an accredited/certified American Society for Non-Destructive Testing (ASNT), Level III in the inspection discipline,

may submit certifications to the Office of Materials and Technology, Metals Group for review.

Where a manufactured pile type is designed to be spliced by screwing two pieces together or by the use of couplings or collars, and the details for the splice are not specified in the Contract Documents, the device shall be submitted to and approved by the Engineer before use.

It is intended, when practical, that piles be driven in a continuous operation, and that splicing be performed prior to approaching the estimated tip elevation.

**410.03.05 Test Piling.** The depth of penetration and the length of piling for structures will generally be determined by driving test piles. The Contract Documents will specify the test pile locations, minimum penetrations and bearing values and estimated tip elevations. From this information the Contractor shall order and drive the test piling. The actual safe bearing value of the test piling can then be determined as specified in 410.03.09. From the test pile data and observed behavior, the Contractor shall order the permanent piling required to complete the work.

**410.03.06 Pile Driving.** The Contractor shall submit to the Engineer, a plan of the pile driving method, including type of hammer, for approval prior to driving any piling.

The hammer to be used for driving permanent piles shall be the same hammer that was used to drive the test piles. If the Contractor changes hammers, the Contractor shall drive additional test piles at no additional cost to the Administration, before driving the permanent piles, even if the energy ratings of the hammers are identical.

Hammers shall be operated at speeds recommended by the manufacturer for the bearing value specified. The manufacturer's manual for the hammer employed shall be available to the Engineer at the project site.

Hammer energy is defined for the purpose of these Specifications as the approved rated energy per blow of the power hammer.

Tests will be directed by the Engineer to determine the acceptability and energy rating of power hammers. The Contractor shall pay all costs, including the Administration's expenses, for approval and energy rating of any pile driving hammer.

When considering the hammer for approval, the ratio of the weight of the pile to the weight of the striking unit will be evaluated to determine the adequacy of the hammer.

Leads or spuds shall be constructed to afford freedom of movement of the hammer during the driving phases. The Contractor shall drive the piles within the tolerance as specified without injury to the piles. Any leads that do not produce satisfactory end results in the driving of piling shall be removed from the work.

Driving with the hammer out of the leads is prohibited.

On all special, marine or water projects and pile bents, the leads shall be of sufficient length so that the use of a follower will not be necessary. Long piles and batter piles may require guides at intervals and additional support to prevent excessive bending or buckling under the hammer blow. Piles shall be held in place and alignment by templates or other means approved by the Engineer.

External jetting of any piles is prohibited. If it is necessary to remove material from within a pile shell to advance the pile tip or merely to obtain room for concreting, a minimum of 10 ft soil plug shall be left undisturbed at the tip of the pile. Turbidity curtains shall be installed around the piles being cleaned.

Where piling must perforate strata which resists driving, the Contractor shall auger or drill holes through the strata. The size of the auger or drill to be used shall not be larger than the nominal diameter of a round pile or the minimum diameter of a circle in which an H pile will fit and shall be approved by the Engineer before use. After the hole is completed, the pile shall be inserted and dry sand shall be used to completely fill any voids between the pile and the walls of the hole. Driving shall then be completed, after which any remaining voids shall be completely filled with dry sand.

#### **410.03.07 Pile Driving Tolerances.**

- (a) **General.** Foundation piles shall not be used out of the position specified in the Contract Documents by more than 6 in. in any direction after driving, regardless of the length of piles. Variation from the vertical or from the batter shall not be more than 1/4 in./ft.
- (b) **H Piles.** Rotation of the pile in excess of 25 degrees from the as planned axis is prohibited.

- (c) **Bents.** Piles shall be driven so that the cap may be placed in its proper location.

**410.03.08 Unacceptable Piles.** Any pile not in conformance with the Contract Documents shall be corrected by one of the following methods or other methods approved by the Engineer at no additional cost to the Administration:

- (a) The pile shall be withdrawn and replaced by a new pile.
- (b) A second pile shall be driven adjacent to the unacceptable pile.
- (c) The pile shall be spliced or built up (except timber piles).
- (d) A sufficient portion of the footing shall be extended to properly embed the pile.

**410.03.09 Bearing Value.** The determination of the bearing value shall be primarily obtained from observation and reporting of the behavior of the test pile from the time first placed in the leads until it attains practical refusal or reaches a stratum specified in the Contract Documents or as directed by the Engineer. To furnish the Engineer and Contractor with a guide as to the probable supporting value at each position, the Engineer will compute the safe bearing value from the following formula:

$$P = \frac{2WH}{S + 0.1} \text{ for single acting power hammers}$$

$$P = \frac{2E}{S + 0.1} \text{ for double acting power hammers}$$

where:

- P = safe bearing value in pounds.
- H = height of fall in feet.
- W = weight in pounds of striking parts of hammer.
- E = approved hammer energy per blow in foot pounds for double acting, differential acting, and diesel hammers.
- S = the average penetration in inches per blow for the last several inches of penetration.

The above formula is applicable only when:

- (a) The hammer is operating properly and at the manufacturer's recommended speed in the case of a power hammer.

- (b) The head of the pile is not broomed or crushed.
- (c) The penetration is reasonably quick and uniform.
- (d) There is no discernable bounce after the blow.
- (e) A follower is not used.

If the Contract does not provide for test loading, the results of this formula as applied to the test piles shall be used to designate the proposed penetration or lengths of piles. However, each pile shall have its driving record evaluated to assure its ability to carry the intended load.

Test piles shall be driven in permanent vertical pile locations as directed by the Engineer or as specified in the Contract Documents. Test piles found to be satisfactory by the Engineer shall be utilized as permanent piles.

**410.03.10 Pile Cutoff and Removal.** The tops of all piles and pile casings, except timber piles that support timber caps, shall be cut off at the elevations specified in the Contract Documents and on a true plane perpendicular to the axis of the pile unless otherwise specified. Timber piles that support timber caps shall be cut off to ensure that the plane of the bottom of the cap will bear fully on the pile head. Shimming between the timber cap and pile head is prohibited.

Piles used for sheeting and shoring shall be cut off a minimum of 1 ft below existing grade, channel bottom or mud line as applicable. When specified in the Contract Documents, these piles may be removed. The Contractor shall dispose of all removed material on approved spoil areas.

**410.03.11 Steel Pipe Piles.** After driving, soil plugs shall be removed to the elevation specified in the Contract Documents. Prior to placing filling (when specified) or reinforcement, steel pipe piles shall be inspected with the aid of a suitable light for illuminating the interiors of the piles for their entire unplugged length. No filling or reinforcement shall be placed until the Engineer approves the pile.

The Contractor shall provide all required equipment for inspection including oxygen, light, boatswain's chair and lift. The Contractor shall comply with federal and local safety regulations while performing this work.

**410.03.12 Concreting Steel Pipe Piles.** Concrete work shall conform to Section 420. Reinforcement shall conform to Section 421 and shall be securely fastened together to form a cage which shall be positioned and held at a uniform distance from the shell.

Tie bars and bands for reinforcement cages of foundation (footing) piles shall be tie wired. Tack welding may be used, provided an Administration certified welder is used.

Tie bars, bands and spacer lugs for bents or column piles shall not be tack welded to any of the main reinforcement bars except that the Contractor may place a band at the top and bottom of the pile cage and weld all main bars to the band. The remainder of the intersections of ties and main bars shall be fastened by tie wiring.

The top portion of the pile shall be cleaned in the areas to be filled with reinforced concrete and tremie concrete as shown on the Contract Documents. Tremie concrete shall be placed and cured prior to dewatering the top of the pile shell. The reinforcement unit shall be placed in the top portion of the pile prior to filling with Mix No. 3 concrete. All work shall conform to the Contract Documents and as directed by the Engineer.

Concrete shall not be placed in any pile until all driving within a radius of 15 ft has been completed or until all the piles for any unit of the structure (pier, bent or abutment) have been driven to their final penetration and accepted by the Engineer. In the event that this procedure cannot be followed, all driving within the above limits shall be discontinued until the concrete in the last pile placed has set a minimum of 72 hours.

Immediately prior to concreting, water or other foreign substances found in a pile shall be removed. The concrete shall be deposited in one continuous operation. The restriction in Section 420 for dropping concrete more than 5 ft shall not apply.

Reinforcement steel cages shall be set and fastened in proper position in the pile before any concrete filling is placed, except when the reinforcement steel cage extends 6 ft or less below the top of the pile, the concrete filling may be placed before the reinforcement is installed. Concrete deposited in piles shall be thoroughly consolidated with mechanical vibrators from the bottom of the reinforcement steel cages to the tops of piles.

Freshly concreted piles shall not be disturbed in any way nor shall any loads be allowed upon any of them until all concrete has been in place and cured a minimum of 72 hours.

**410.03.13 Treatment for Timber Pile Heads.** Timber pile heads that are not to be imbedded in concrete shall be painted with an approved asphalt treatment. After the asphalt has sufficiently cured, it shall be covered with a glass resin composite shield. The first coat of resin shall

be applied to the top and down the side a minimum of 1 in. beyond the limits of the woven glass. Precut woven glass cloth shall be applied using a 3 in. grooved aluminum roller to achieve "wet out." Woven glass cloth shall be neatly wrapped over the top of the pile, draped down the side a minimum of 2 in. and nailed with copper nails. When the first coat of resin has taken a tack free set, a second coat of resin shall be applied to seal the entire application.

**410.04 MEASUREMENT AND PAYMENT.** The payment for the items specified in the Contract Documents will be full compensation for all material, labor, equipment, tools, and incidentals necessary to complete the work.

**410.04.01** Piling (permanent and test) will be measured and paid for at the Contract unit price per linear foot for the pertinent Piling item. The measured length of all piling will be taken from its tip up to final cutoff unless otherwise specified in the Contract Documents. For test piles not utilized as permanent piles, the measurement for cutoff will be at the same elevation as the nearest proposed permanent pile or to actual top of test pile, whichever is lower. Where piling designated as test piles is accepted for use in the permanent structure, measurement will be made as test piles and no additional allowance will be made in other piling items.

**410.04.02** Furnishing and setup of pile driving equipment required for driving permanent and test piles will not be measured but the cost will be incidental to the Contract unit price for the pertinent Pile item.

When an item for Setup for Driving Pile is included in the Contract Documents, the furnishing and setup of pile driving equipment required for driving permanent and test piles will be measured and paid for at the Contract unit price per each for the pertinent Setup for Driving Pile item. The unit price per each for the setup required for driving each pile for the proposed structure will be used regardless of the distance that the equipment must be moved for each pile setup. A maximum of one setup will be paid per pile location. No additional compensation will be paid for any setup required for redriving or any additional driving of any pile no matter what reason the particular pile may require redriving or additional driving.

**410.04.03** Pile points for steel H piles will be measured and paid for at the Contract unit price per each for the pertinent Pile Point for Steel H Pile item.

**410.04.04** Timber sheet piling will be measured and paid for at the Contract unit price per 1000 board foot for the pertinent Timber Sheet Piling item. Computation of quantities will be based on nominal thickness of lumber, the length of the sheet piling, and the average depth



of the sheet piling from cutoff at the top to the tip of the sheet piling in the completed structure. No allowance will be made for waste.

**410.04.05** Steel sheet piling will be measured and paid for at the Contract unit price per square foot as measured along the plane of surface for the pertinent Steel Sheet Piling item.

**410.04.06** The following will not be measured but the cost will be incidental to other pertinent items specified in the Contract Documents:

- (a) When specified, tips for steel pipe piles.
- (b) Test pieces of sheet piling (timber or steel).
- (c) Dewatering, clean out, filler, reinforcement and concrete used in steel pipe piles.
- (d) Pile splices.
- (e) Augering, including sleeve and backfill when required.
- (f) Cleaning, painting, or coating of piling.
- (g) Piling or sheet piling for temporary structures, piles or sheet piling driven for the Contractor's convenience, or for any piles or sheet piling not specified in the Contract Documents.
- (h) Piling not approved by the Engineer, such as piles not properly driven, piles with questionable safe bearing values, piles damaged during driving, or piles driven below planned cutoff or the removal of any pile rejected by the Engineer as unsatisfactory.
- (i) Glass resin composite shield used on timber piles.

## SECTION 411 — PILE LOAD TEST

**411.01 DESCRIPTION.** This work shall consist of applying loads to test piles when the Contract Documents include Load Tests. The load test setup, the measuring system, the loading device, the loading procedure, the frequency of measuring the movement of piles and the record keeping shall conform to D 1143 unless otherwise specified in the Contract Documents or directed by the Engineer.

**411.02 MATERIALS.** Not applicable.